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**Work Plan
Revision I
12686**

**Phase II Work Plan
Remedial Investigation-
Feasibility Study
City Of Sturgis Well Field
Sturgis, Michigan**

Prepared for:
**Michigan Department Of Natural Resources
Lansing, Michigan**

Prepared by:
**Warzyn Engineering Inc.
Madison, Wisconsin**

May 1988

MASTER



Engineers & Scientists
Environmental Services
Waste Management
Water Resources
Site Development
Special Structures
Geotechnical Analysis

May 24, 1988
12686.00

Mr. Steve Luzkow
Michigan DNR
530 W. Allegan
Lansing, MI 48909

Re: Phase II Work Plan, Sturgis Well Field RI/FS

Dear Steve:

Enclosed are two copies of the Phase II Work Plan for the Sturgis Well Field RI/FS Site. Two copies of the Work Plan have also been mailed to Fran Allans at Region V, U.S. EPA.

We anticipate initiation of field activities in June. Please call us by June 6 if you anticipate delays.

If you have questions, please call.

Sincerely,

WARZYN ENGINEERING INC.

Timothy E. Melka
Hydrogeologist

Kenneth J. Quinn
Project Manager

TEM/ndj/KJQ
[jpl-103-24]

cc: Kathy Shirey, MDNR (1)
Francine Allans, U.S. EPA Region V (2)
Jim Gillette, Warzyn (1)



**Phase II Work Plan
Remedial Investigation-
Feasibility Study
City Of Sturgis Well Field
Sturgis, Michigan**

May 1988

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**PHASE II WORK PLAN
STURGIS WELL FIELD RI/FS
STURGIS, MICHIGAN**

This document describes the Phase II Work Plan activities necessary for the performance of the Remedial Investigation/Feasibility Study (RI/FS) of the Sturgis Well Field, Sturgis, Michigan. This document augments Subtask 3.2 and Task 5 of the original Work Plan document of July 1987.

The need for additional RI work results from data gaps identified in the Phase I site investigation. Four areas were identified where releases of tetrachloroethene (PCE) and/or trichloroethene (TCE) have occurred. In addition, a concentrated plume of TCE (>1000 ug/L) was also identified at Well Nest W2 at depth, but not linked to a source. These source areas and plumes require additional characterization to determine:

- the extent of VOC contamination at each release area;
- the source(s) of the identified VOC plumes;
- the extent of the identified VOC plumes with each aquifer;
- the potential for VOC contamination of additional municipal wells.

In addition to the objectives listed above regarding characteristics of the VOC contamination, this Work Plan intends to:

- determine the presence and characteristics of low permeability deposits to the extent they affect contaminant migration.
- determine the presence and extent of other contaminants on the Hazardous Substance List (HSL) in the study area.

This Work Plan was developed with the intent to complete these objectives. However, the complexity of the geology, hydrogeology and number of possible source areas has resulted in a large, complex problem. Therefore, resolution of the entire problem may require a third phase.

Phase II as outlined in this Work Plan includes:

- Continuation of the groundwater flow model initiated in Task 3.2;
- Collection and analysis of additional soil gas samples to help characterize potential source areas identified in the Phase I investigation, and additional potential source areas;
- Performance of soil borings for the purpose of collecting soils for analyses to further characterize potential source areas;
- Installation of additional groundwater monitoring wells at potential source areas and elsewhere to determine the extent of volatile organic compound (VOC) contamination distributions in the upper and lower portions of the aquifer, and to provide additional hydrogeologic information (e.g., groundwater flow directions and rates).
- Identification of the potential need for additional field investigations subsequent to Phase II, if any.

There are 3 intermittent surface water drainage swales located within 1/2 mile of the city to the south and west. These surface water swales are not proposed to be sampled at this time for 2 reasons:

- The swales are above elevation 870 within 1 mile of the City, whereas the water table is below 870 within the City. Therefore, they are not receiving groundwater discharge (which is why they are intermittent).
- Flow within these intermittent streams is not expected to be present during the course of Phase II (currently anticipated for summer 1988).

However, each swale will be inspected to confirm these conditions. If surface water is present, a field decision will be made in conjunction with MDNR on whether to sample it. This will be conducted during Subtask 5.4 Phase II Well Drilling.

Subtask 3.2 Preliminary Groundwater Modeling

The two layer groundwater model developed prior to the Phase I investigation was useful in evaluating the Layne-Jackson and Kirsch well's potential capture zones within the principal aquifer and in identifying the hydrogeological parameters which may control flow rates and directions. Results of the Phase I investigation have indicated relatively complex hydrogeologic conditions control the groundwater flow directions and rates.

Three distinct aquifers separated by two clay/till layers are present in at least portions of the city. This requires adding another aquifer and confining layer to the model. Simulation of a three-aquifer system adds a substantial amount of effort to preparing and evaluating each model run, although preliminary results indicate this model will more closely match observed conditions.

Continuation of the preliminary model will be used initially for two purposes: 1) transient simulation of observed conditions to calibrate the model and evaluate potential source areas, and 2) evaluation of potential water supply well locations to assist the City in decisions to add capacity to their system. Following calibration to existing conditions, with modifications based on Phase II results, the groundwater flow model will be used to evaluate the no action alternative. Costs for this effort are covered by rebudgeting from other tasks. The model will also be used in the Feasibility Study for analysis of other remedial action alternatives.

Task 5 - Phase II Field Investigation

Subtask 5.1 Phase II Plan Revisions

In order to conduct the Phase II Investigation, several plans need to be modified. The QAPP, Sampling Plan and Health and Safety Plan will be revised and completed prior to initiating field work. Final revised plans will be based on one set of comments compiled by MDNR. One meeting is planned to be held with MDNR to discuss changes in the Work Plan and supporting plans. Prior to initiating field work, the drilling subcontractor(s) will meet with the project manager, field team leader and MDNR to discuss specific details of the drilling and sampling methods.

Subtask 5.2 - Site Mobilization and GC Set Up

Remobilization of the field investigation team and the gas chromatograph (GC) will be required prior to initiation of field activities. The site trailer will be maintained at the Sturgis Wastewater Treatment Plant (WWTP), as in Phase I. The decontamination area for the drilling equipment will also be located at the WWTP, as in Phase I.

Assumptions for costs pertaining to this subtask include:

- The set up and calibration of the field GC will occur during the two days preceding the initiation of the Phase II field work;
- Approximately one day will be required prior to mobilization to inspect and load field equipment.

Subtask 5.3 - Soil Gas Survey

Soil gas sampling with on-site analysis was performed in Phase I to help identify potential source areas and map the VOC plume present at the water table in the immediate vicinity of a source area. The Phase I soil gas results helped to identify potential source areas, and was used in locating discretionary wells at three of these locations. The Phase II soil gas survey is designed to further characterize these potential source areas in an effort to optimize well placement.

A total of fifty soil gas samples will be collected at the following locations: Kirsch Municipal Airport (10), Telemark Business Forms (5), Wade Electrical Products (10), Kirsch Company Plant #1 (10), and the Sturgis Iron and Metal facility (15) located at 317 Center Court, over a 10 working day period. Each facility (except Sturgis Iron and Metal) was identified in Phase I as having VOC in the soil gas, groundwater or both. Sturgis Iron and Metal was identified to be included in the Phase II survey because it is apparently upgradient of groundwater contamination identified at Wells W-11S and W-2I.

Soil gas sample collection methods will be the same as the methods described in Task 4.3 of the original Work Plan, if done in the summer. If performed in the winter or spring, the following change will be made. A shallow boring will be performed to allow collection of the gas sample below the frost layer, or below the zone of moisture present near the ground surface during the spring thaw. A drill rig will perform the boring to a depth of approximately five feet. The purpose for drilling the five foot hole is to sample from a

zone where high moisture or low temperature have minimal effects on removing VOCs from the soil gas. A soil gas sampling rod (a drill rod fitted with sampling ports on the tip) will be driven two to three feet past the end of the augers. The drive head will be removed from the soil gas sampling rod and a sampling head threaded on. The soil gas sample will be collected in an air sample bomb after purging two volumes of the sampling device.

Decontamination will consist of purging more than 10 volumes of air through the sampling device and brushing soil off the lead sampling rod and lead auger. Steam cleaning will be conducted only if oily soils are encountered or cross contamination is indicated by the field GC results.

To develop costs for the Phase II soil gas program, the following assumptions were used:

- Soil gas samples will be collected and analyzed over a 12 day period;
- One field person and a drill rig crew will be required for sample acquisition;
- HNu monitoring and Level D site safety will be required during sampling.

Subtask 5.4 - Phase II Well Drilling

Seventeen groundwater monitoring wells were installed in Phase I for the purpose of determining general physical and chemical character of the aquifer underlying the City of Sturgis. Wells were installed at Wade Electrical, Telemark Business Forms, Sturgis Newport Business Forms, and Kirsch Company Plant No. 1 (Prospect and Hatch Streets) to investigate positive VOC analyses of soil gas samples. At each location, except Sturgis Newport Business Forms, these wells showed detections of TCE and/or PCE in water samples collected at the water table and screened by the on-site GC. Other wells installed during Phase I showed elevated concentrations of VOCs below the water table, as determined by analysis of water samples collected while drilling. Notably, the highest concentrations of VOCs observed during the course of the Phase I drilling were detected in water samples collected below 70 feet, while

drilling at Well Nest location W-2 (above 1000 ug/L) on N. Monroe St. Well W-2I was installed to a depth of 100 feet at the zone of highest contamination to evaluate the potential contaminant migration from a source up the groundwater gradient toward the Layne/Jackson wells. The boring log of soils at Well Nest W-2D, and water levels collected at wells W-2S, W-2I and W-2D, indicated that essentially a single aquifer was present at this location from the water table surface to a depth of approximately 150 ft. This geologic condition differed greatly from data collected from other deep borings performed during Phase I drilling, where one or two low permeability units were identified within the aquifer (generally encountered at 40 to 100 feet). Significant variations between piezometric and water table conditions were also noted at the other borings. Finally, the proximity of the high VOC concentrations at location W-2 to the uncontaminated Lakeview and Oaklawn municipal wells necessitates expanding the Phase II drilling work scope to include both characterization of identified source areas and the monitoring of conditions between potential source areas and the uncontaminated municipal wells.

Phase II wells will be installed to collect groundwater level and groundwater quality data. Thirty-seven wells for a total of 3400 feet of drilling and well installation are planned for the Phase II field investigation. This total number of wells is broken into 2 subtasks in the budget (Table 2). Subtask 5.4.1 Well Drilling consists of 26 wells at 21 specified locations for a total of 2420 ft (see Figure 1). The rationale for these locations is presented in Table 1. Figures 2 and 3 from the Phase I Technical Memorandum are included to illustrate general groundwater flow directions (refer to Phase I Tech Memo for additional information). The eleven remaining wells (980 ft of drilling) will be held in reserve as discretionary wells and are budgeted separately in Subtask 5.4.2 Discretionary wells.

These wells, if needed to characterize source or migration routes, will be located based on results of soil gas, groundwater quality samples, and soil samples collected and analyzed for target VOCs by the on-site GC while drilling, to further characterize source areas or potential migration routes.

In particular, wells may be used to determine the extent of contamination within each aquifer. For example, discretionary wells may be installed:

- to the southwest, toward surface water discharge areas to determine whether contamination is moving in that direction,
- to the northeast, upgradient of known potential sources, if current planned wells turnout to be on the downgradient side,
- within areas where 3 separate aquifers are present to upgrade a planned 2 well nest to a 3 well nest, to characterize water level and quality in each aquifer.

Subtask 5.4.3 Remobilization includes costs for demobilization after Subtask 5.4.1 and remobilization for Subtask 5.4.2. The purpose for including Subtask 5.4.3 Remobilization is in the event that for budgetary or other reasons there is a break in the on-site activities between the drilling subtasks, this plan provides the budgetary flexibility to proceed within a reasonable schedule.

Shallow borings will be performed using 4 1/4 in. I.D. hollow stem augers, and wells will be installed and completed using materials and methods described in Subtask 4.4 (Well Drilling) of the original Work Plan (July 1987). Deep wells will be drilled using screened 4 1/4 in. hollow stem augers until a 5-foot thick confining layer is encountered or where VOCs have been detected above the confining layer. If no confining layers are encountered, or no VOCs detected, hollow stem augers will be used to the total depth of the well or the maximum depth possible with that method. If a confining layer greater than 5 feet in thickness is encountered with VOCs detected above it or the hollow stem auger cannot be used to the entire depth, the augers will be filled with a thick drilling mud, the augers retracted and 8-in. casing welded and set in a bentonite seal in the clay and 6-in. casing telescoped inside. The augers will be retracted and casing installed as rapidly as possible to limit the potential for mud loss to the formation. Drilling will progress using air rotary methods while advancing the 6-in. casing.

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The drilling rig selected for the air rotary drilling has the capability to advance 8 and 6-in. casing only. Therefore, if VOCs are present above two separate clay layers, drilling will be terminated; the well set, and alternate drilling methods agreed on with MDNR.

Split spoon soil sampling will be performed in general accordance with ASTM Method D1586. The only deviation anticipated is to use the casing hammer for driving the spoon with the air rotary rig. Sampling will be performed on 5-ft intervals to a depth of 30 ft, and on 10 ft intervals to the terminus of the borehole. Soil samples from each interval above the water table will be screened using an HNu. A field GC analysis will be conducted to improve on the detection limit of the field HNu screening. A sample will be collected in the field in a VOA vial with deionized water added to fill 1/2 the vial. A field GC analysis will then be conducted on selected soil samples using the head space method for water in Appendix G of the QAPP. The result will be reported as detected/not detected because of the unquantifiable extraction method.

During Phase I, approximately 10% of the soil samples were shipped to CLP for compound and concentration confirmation through analysis of VOCs by GC/MS. These included samples from continuous clean zones, the dirtiest zones, and others as necessary to reflect transitions between high and low concentration zones. The same selection criteria will be used during Phase II.

Groundwater quality samples will be collected at 10-foot intervals in relatively high permeability soils while drilling, using the sampling techniques outlined in Subtask 4.4 of the original Work Plan, when drilling with air rotary methods. This involves driving a well point, then purging and sampling from the well point with a PVC hand pump or a submersible pump. Sampling when drilling with the screened hollow stem augers will involve developing the zone using air lift or pumping and then collecting the sample with a PVC hand-pump or a submersible pump.

WARZYN


Each of the deep wells drilled in Phase II will be gamma ray logged. The selection of the vertical position of the well screen will be determined by the gamma ray log, visual observations of subsurface soil samples, and on-site analyses of the water quality while drilling. The deep well screen will be placed in the zone of highest VOC concentration. If the gamma ray log or visual observations indicate another location should be screened, the situation will be discussed with the MDNR, if possible, prior to setting the well. For example, this may result in 3 well nests utilizing a discretionary well where 3 distinct aquifers are present. We do not anticipate installation multiple wells within a single aquifer (e.g. 2 wells in the upper aquifer) unless VOC concentrations change within the aquifer. Water level differences between aquifers appear to occur within the confining layers, not within the aquifers themselves. Well construction will also be consistent with the methods described in Subtask 4.4 for Phase I drilling.

Decontamination of drilling equipment and materials, containment and disposal of purge water and drilling spoils, and well development will be performed as specified in Subtask 4.4 of the Phase I Work Plan. Contaminated water will be retained in drums, if concentrations of VOCs in the water exceed the acceptable limits for disposal in the City sanitary sewer. Warzyn will stage the drums at the site trailer and sample them for determining appropriate disposal methods. MDNR will then dispose of all drummed waste as appropriate. A location and elevation survey of the Phase II monitoring wells will be performed following well installation.

Selected soil samples (approximately 50) will be submitted to the CLP for grain size analysis and natural organic content. The grain size analyses will be used to help classify the soils. The natural organic content will be used to aid in estimating potential attenuation characteristics of the aquifer.

When approximately two-thirds of the Phase II drilling program is completed, results of the Phase II soil gas survey, groundwater sample analysis during drilling, and soil headspace sample analysis will be evaluated. If needed, an augmentation to the Work Plan will be prepared to address additional Phase II data needs. Similarly, the Phase II budget will be revised to reflect costs

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associated with implementation of additional field activities. During the course of the Phase II drilling program, the 3 subsurface water drainage swales shown on the USGS quadrant map within 1 mile of the city will be inspected. If water is flowing within the swales from natural sources (e.g. not a facility discharge or irrigation runoff), samples will be collected suitable for VOC analyses. A decision on whether to submit the samples for analysis will be made with the MDNR and U.S. EPA.

Assumptions for developing costs for Phase II drilling are:

- 37 wells at 29 locations are planned to be installed;
- 3400 ft of drilling is planned using 2 drill rigs—a hollow stem auger rig and an air rotary rig;
- Drilling will require 60 field days for two drilling rigs plus 6 days of travel;
- The field crew will consist of two geologists, an on-site GC operator and a team leader/site safety officer;
- 90% of the drilling will be done in level D protection and 10% in level C;
- HNu monitoring for site safety will be performed by the rig geologist;
- A maximum of 152 water samples will be collected while drilling and analyzed by the on-site GC, including blank and duplicate samples;
- Access agreements between property owners and MDNR that have been executed will carry through this phase. Agreements will be executed for properties not yet investigated prior to initiation of Phase II drilling. This includes access to Sturgis Iron & Metal, and Federal Aviation Administration (FAA) approval to drill at the Kirsch Municipal Airport;
- Up to 136 soil samples will be screened by the GC during drilling, including blank and duplicate samples;
- 50 water samples and 29 soil samples analyzed on-site may be shipped to CLP for GC/MS analysis, including blank and duplicate samples.
- 50 soil samples will be submitted to the CLP for grain size and natural organic content analyses.



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Assumptions for breaking out costs between Subtasks 5.4.1 and 5.4.2 are:

Subtask 5.4.1 Well Drilling

- 26 wells at 21 locations will be drilled;
- 2420 feet of drilling is planned;
- Drilling will require 44 days of 2 rigs and 5 travel days.

Subtask 5.4.2 Discretionary Wells

- 11 wells at 8 locations will be drilled;
- 980 feet of drilling is planned;
- Drilling will require 16 days of 2 rigs and 1 travel days.

Cost assumptions for Subtask 5.4.3 Remobilization are:

- for budgetary or other reasons a project delay between Subtasks 5.4.1 and 5.4.2 will necessitate demobilizing all equipment except the trailer.
- remobilization will require mobilization of the field GC 1 day prior to mobilization of the drilling rigs and crews.

Subtask 5.5 - Soil Borings

Twenty soil borings will be performed to characterize organic contamination at four separate potential source locations. A drill rig will be used to perform the borings. Soil samples will be collected on 5-ft intervals to examine organic concentration gradients in the soil column. Sample intervals may be extended to 10 ft below 30 ft if concentration gradients are low. A 3-in. diameter split spoon sampler will be used to obtain the samples. Selected samples will be shipped to CLP for RAS, HSL analysis. Borings will be conducted on Wade Electrical (5), Telemark Business Forms (3), Kirsch Co. Plant No. 1 (7) and Sturgis Iron and Metal (5) properties. The exact locations of these borings will be determined in the field following the soil gas survey (Subtask 5.3) and will be dependent on analyses of soil gas samples collected in either Phase I or Phase II, and observations made by the site team leader.

Access to several of the Wade Electrical, Telemark and Sturgis Iron & Metal soil boring locations may require removal of trees and excavation of drilling platforms or pathways to the proposed boring locations.

Assumptions used to develop costs for this subtask include:

- Tree removal and soil excavation will be performed by a subcontractor over a three-day period to provide access to sampling locations;
- One geologist and one drill rig will be required for seven days to collect the soil samples;
- 90% level D and 10% level C protection will be required for sample collection. The geologist on the rig will also monitor the drilling operation with an HNu for site safety;
- Up to 20 soil samples, 2 blanks and 2 duplicate samples (24 total) will be shipped to CLP for RAS, HSL priority pollutant analysis. Up to 80 soil samples, 8 blanks and 8 duplicate samples will be shipped to CLP for RAS, VOA analysis. Samples are assumed to be medium or low concentration samples.

Subtask 5.6 - Round Three Groundwater Sampling and Phase II Hydraulic Conductivity Tests

In addition to the groundwater sampling completed in Phase I, 37 monitoring wells (installed during Subtask 5.4), four municipal wells, two test wells, six industrial process wells and 22 pre-existing wells will be sampled. These samples will provide additional information pertaining to source area characterization, extent of contamination and mass of contaminants present, and will aid in the evaluation of remedial actions. This round of sampling will provide a third set of analyses on wells existing prior to the RI, 2 sets on the Phase I wells and 1 set on the Phase II wells. A fourth round of sampling will be considered if:

- results of this round are inconsistent with samples collected during drilling or previous analyses;
- there is more than 6 months between the Round 3 sampling and the FS; or

Sampling methods, purge water disposal, equipment used and decontamination procedures will be the same as those used in Subtask 4.6. Groundwater samples will be analyzed for the following parameters:

Conductivity (field)	Alkalinity
Temperature (field)	Sulfate
pH (field)	Chloride
Volatile Organics (VOCs)	Nitrate+Nitrite-Nitrogen
Magnesium	Total Kjeldahl Nitrogen
Sodium	Total Organic Carbon
Potassium	Calcium

The VOCs analysis is intended to be low level GC/MS through a SAS.

It is anticipated that 12 monitoring wells installed in potential source areas (based on high VOC concentrations from field GC results) and high VOC concentration zones of the aquifer, and each municipal well will be sampled and submitted to the CLP for HSL analyses by RAS. Sampling will occur approximately one month after completion of Subtask 5.4.

Hydraulic conductivity tests will be conducted on 15 wells installed in Subtask 5.4 using methods described in Subtask 4.6 of the original Work Plan (July 1987). Five shallow wells will be tested using single well pumping test techniques. A Johnson-Keck submersible pump will be used for the tests. Each of the five wells will be pumped for approximately 100 minutes. Purged water will be disposed in the City sanitary sewer. Drawdown and recovery will be measured and evaluated to determine hydraulic conductivity. Results from the single well tests will be compared to results obtained from shallow well baildown tests conducted during Phase I.

The following assumptions were used in developing costs for this subtask:

- Water quality sampling will require a six-person team. Two teams of two people will collect the samples, one person will be responsible for sample preparation, and one person will provide chain of custody documentation and handle sample shipment;
- Sampling will require thirteen 12-hour days plus two days of travel;

- Sampling will be conducted at Level D. Work at Levels C or B is not anticipated and would be considered out of the budget scope;
- 70 groundwater, 7 duplicate, 7 blank samples, 4 trip blanks and 4 matrix spikes will be collected and submitted to CLP for analysis of VOCs and general water quality parameters. Twelve of the 70 groundwater samples will be collected for complete HSL scan;
- Hydraulic conductivity tests will be conducted by a hydrogeologist and technician team during five 12-hour days;
- Groundwater samples will be of low concentration. Continuous HNu monitoring will be performed during purging and sampling.

Subtask 5.7 - Phase II Groundwater Level Monitoring

Upon completion of the Phase II well installation program, water levels will be measured at wells installed in Phases I and II, and the pre-existing monitoring wells. Water levels will also be measured concurrent with groundwater sampling and during four additional rounds during the RI. Measurement equipment and levels of protection will be consistent with those described in Subtask 4.7. Each of the four independent water level monitoring events will require two-12 hour days, including travel (96 total hours).

Subtask 5.8 - Phase II Analysis

After completion of the Phase II field investigation, data will be reviewed, and a Technical Memorandum will be prepared. The Phase II Technical Memorandum will summarize RI activities performed during Phase II, including:

- Methods and procedures used for water quality, soil gas and soil sampling;
- Phase II drilling methods, boring logs, well construction details and hydraulic conductivity results;
- Results of field analysis of soil and soil gas samples;
- CLP laboratory analysis results for the Phase II investigation, if available;
- A summary of the water level monitoring program completed through the date of the report;
- Recommendations for future work at the site.

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Five copies of the draft Technical Memorandum will be distributed to MDNR for comments. After review of the Technical Memorandum, a meeting will be held in Lansing with Warzyn, MDNR and EPA to discuss Phase II results, and to determine whether additional investigation is warranted. If no additional investigation is needed, the RI Report will be prepared.

Schedule and Cost

The schedule for proposed implementation of the remaining portion of the RI is shown in Figure 4. This schedule is for continuous implementation of both the planned and discretionary wells (Subtasks 5.4.1 and 5.4.2).

The costs for completing Phase II of the RI are presented in Table 2. Three separate totals are provided. The basic option does not include Subtasks 5.4.2 Discretionary Wells and 5.4.3 Remobilization. The complete option includes Subtask 5.4.2 and assumes the discretionary wells are installed without demobilization after Subtask 5.4.1. The remobilization option includes remobilization between Subtasks 5.4.1 and 5.4.2.

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TABLE 1
PROPOSED PHASE II WELL LOCATIONS
STURGIS WELL FIELD RI/FS
STURGIS, MICHIGAN

<u>Total Well No.</u>	<u>Drilling Ft*</u>	<u>Rationale</u>
<u>Task 5.4.1 Well Drilling</u>		
W-12S	60	To characterize groundwater flow and water quality at the airport which is a potential source area based on Phase I soil gas results
W-13S	60	
W-14S	60	
W-15S	60	To characterize water quality at Telemark where VOCs have been identified in the groundwater and soils.
W-16S	60	
W-17S	50	To characterize water quality at Wade Electrical which is a potential source area based on soil and groundwater analyses.
W-18S	50	
W-19S	50	
W-11D	200	To characterize groundwater flow and water quality at Kirsch #1 and Sturgis Iron and Metal. Groundwater flow directions, Phase I soil gas and soil analysis results indicate a source may be located in this area.
W-20S	70	
W-21S	70	
W-22S	70	
W-23S	70	
W-24S	70	
W-25S	70	
W-26S	60	To characterize groundwater flow and water quality downgradient from Kirsch #1 and Sturgis Iron and Metal (a potential TCE/PCE source area) and to determine the extent of confining layers downgradient of this area.
W-26D	200	
W-27S	50	To characterize geology, groundwater flow and water quality between Wade Electric (potential TCE/PCE source area) and a potential window in the confining layers which separates the upper and lower aquifer in the western half of the City.
W-27D	200	



<u>Total Well No.</u>	<u>Drilling Ft</u>	<u>Rationale</u>
W-28S W-28D	60 200	To characterize geology, groundwater flow and water quality between Kirsch #1 and Sturgis Iron and Metal and the Lakeview municipal well.
W-29S W-29D	60 200	To determine the extent of a potential window in the confining layers and characterize groundwater flow and water quality at a location between two potential TCE/PCE source areas Wade and the Kirsch #1/Sturgis Iron and Metal area and the Lakeview and Oaklawn municipal wells.
W-30S W-30D	70 200	To characterize geology, groundwater flow and water quality at a location between a (Kirsch #1/Sturgis Iron and Metal) potential TCE/PCE source area and Ross Labs Industrial supply wells.
W-31S	50	To evaluate potential groundwater contamination identified by the Phase I soil gas survey in the United Drive Area.

Task 5.4.2 Well Drilling

Discretionary		
8 wells	100 each	These discretionary wells will be installed if necessary, to fill data gaps based on interpretation of the field GC results. The costs are estimated assuming each well will be drilled and installed as a single well. Purposes include an upgradient well to northwest, if all planned wells are in contaminated areas, upgrade 2 well nests to 3 well nests where 3 separate aquifers are present or to track contaminant plumes into areas where no wells are currently planned.
3 wells	60 each	

*Actual depths will be based on conditions encountered
(e.g. water table depth, depth of contamination, etc.)

TEM/jpl/DWH
[jpl-400-33a]
12686.00



TABLE 2
COST ESTIMATES
REMEDIAL INVESTIGATION WORK PLAN
PHASE II

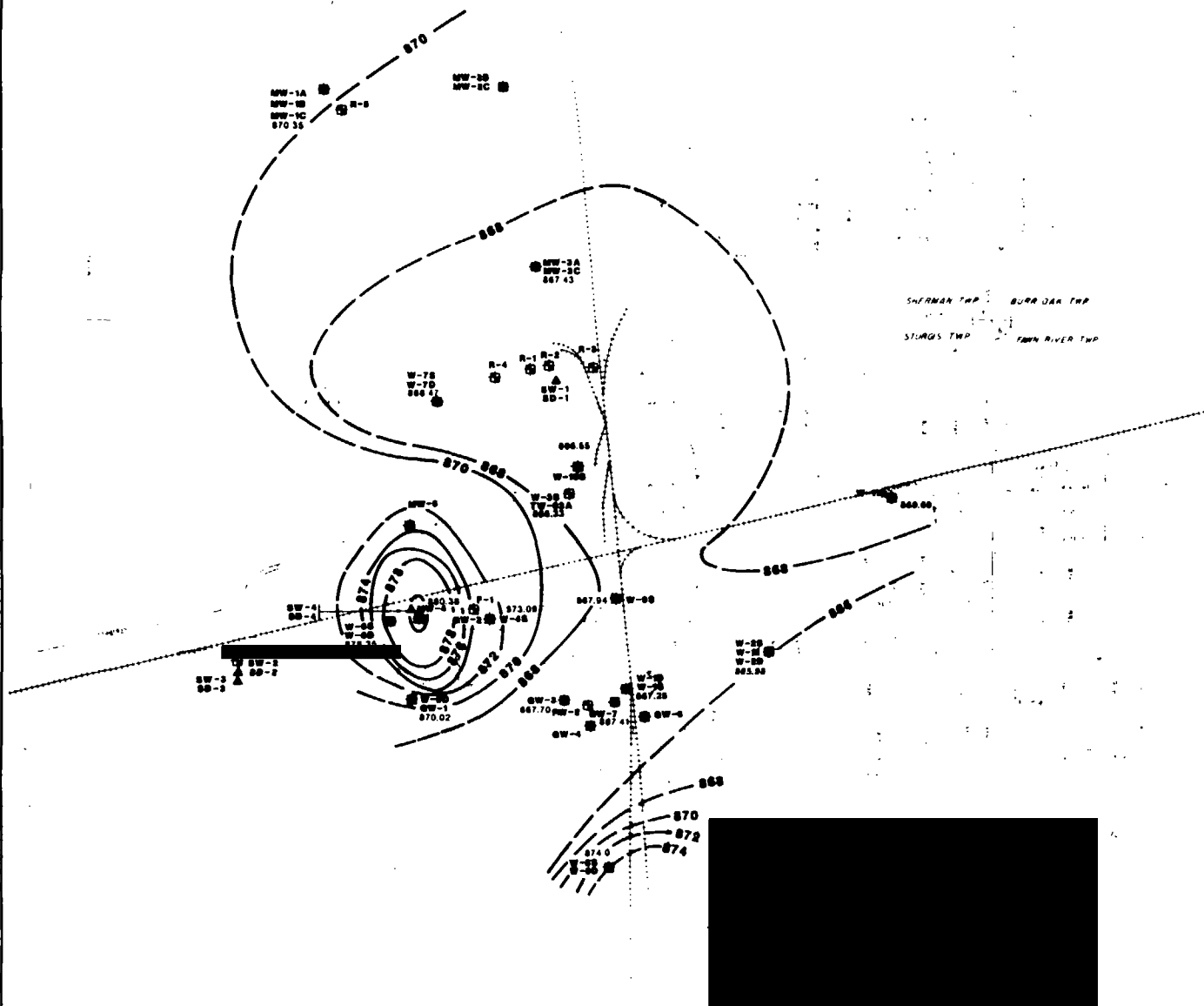
	TASK 5.1 DEVELOP PLANS	TASK 5.2 MOBILIZE & SET UP	TASK 5.3 SOIL GAS SAMPLING	TASK 5.4.1 WELL DRILLING	TASK 5.4.2 DISCRETIONARY WELLS	TASK 5.4.3 REMOB FOR 5.4.2	TASK 5.5 SOIL BORINGS	TASK 5.6 GW SAMPLE & PERM. TESTS	TASK 5.7 WATER LEVELS	TASK 5.8 PHASE II TECH MEMO	SUBTASK 7.1 PHASE II DATA VALIDATION	TASK 8 R1 PROJ MGT	R1 TOTAL
Labor (hrs)													
P4	10									4		100	114
P3	50		8	50	12	12	8	8	4	35	170	150	507
P2	80	24		694	242	72			4	100		90	1306
P1	32		144				94	64		20	560	80	994
T2		36				8		180	16	70		24	334
T1										60			60
OFFICE	32		8	15	5	10	8	8	2	60	60	180	388
TOTAL LABOR	204	60	160	759	259	102	110	260	26	349	790	624	3703
P4	\$32.34	\$323	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$129	\$0	\$3,234	\$3,687
P3	\$25.05	\$1,253	\$0	\$200	\$1,253	\$301	\$301	\$200	\$200	\$100	\$877	\$4,259	\$12,700
P2	\$18.52	\$1,482	\$601	\$0	\$12,845	\$4,489	\$1,333	\$0	\$74	\$1,852	\$0	\$1,667	\$24,187
P1	\$14.55	\$466	\$0	\$2,095	\$0	\$0	\$1,368	\$931	\$0	\$291	\$8,148	\$1,164	\$14,463
T2	\$10.71	\$0	\$386	\$0	\$0	\$0	\$86	\$0	\$1,928	\$171	\$750	\$0	\$3,577
T1	\$8.93	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$536	\$0	\$0	\$536
OFFICE	\$8.07	\$286	\$0	\$65	\$121	\$40	\$81	\$65	\$16	\$484	\$484	\$1,453	\$3,131
Total Dir Labor Cost	\$3,809	\$987	\$2,340	\$14,219	\$4,830	\$1,800	\$1,633	\$3,124	\$362	\$4,919	\$12,891	\$11,532	\$62,281
Direct Labor Overhead 0.46	\$1,752	\$454	\$1,086	\$6,541	\$2,222	\$828	\$751	\$1,437	\$166	\$2,263	\$5,936	\$5,305	\$28,649
GSA Overhead 1.15	\$4,380	\$1,135	\$2,714	\$16,352	\$5,353	\$2,070	\$1,878	\$3,593	\$416	\$5,657	\$14,824	\$13,262	\$71,423
TOTAL LABOR COST	\$9,941	\$2,575	\$6,160	\$37,112	\$12,607	\$4,699	\$4,261	\$8,154	\$944	\$12,838	\$33,645	\$30,098	\$162,353
Expense Item													
transportation	\$1,510	\$600	\$1,075	\$7,864	\$2,541	\$825	\$219	\$1,125		\$1,105			\$16,864
subsistence	\$360	\$360	\$1,080	\$5,292	\$1,834	\$360	\$630	\$2,340		\$270			\$12,328
total ODC	\$370		\$140	\$500	\$220			\$2,650		\$1,020	\$550	\$1,500	\$6,700
analytical lab		\$900	\$10,800	\$39,600	\$14,400	\$1,800							\$67,500
special equipment			\$1,704	\$11,735	\$3,813		\$6,557	\$6,552					\$30,361
TOTAL EXPENSE COST	\$2,190	\$1,860	\$14,799	\$64,991	\$22,810	\$2,985	\$7,405	\$12,667	\$0	\$2,395	\$550	\$1,500	\$134,132
Subcontracts													
KMA				\$36,206	\$12,697	\$1,477		\$6,255	\$4,409			\$2,073	\$63,117
ENG. INTERN.				\$25,582	\$8,883	\$2,020		\$10,832				\$1,781	\$49,098
MATNESS		\$3,000	\$11,883	\$258,900	\$109,200	\$11,304	\$25,349						\$419,638
LAB													\$0
TOTAL SUBCONTRACTS COST	\$0	\$3,000	\$11,883	\$320,688	\$130,700	\$14,803	\$25,349	\$17,087	\$4,409	\$0	\$0	\$3,854	\$531,653
Fee													
Labor 0.10	\$994	\$258	\$616	\$3,711	\$1,261	\$470	\$426	\$815	\$94	\$1,284	\$3,364	\$3,010	\$16,295
Expense 0.10	\$219	\$186	\$1,480	\$6,499	\$2,281	\$299	\$741	\$1,267	\$0	\$240	\$55	\$150	\$13,415
Subcon. 0.05	\$0	\$150	\$594	\$16,034	\$6,539	\$740	\$1,267	\$854	\$220	\$0	\$0	\$193	\$26,593
TOTAL FEE	\$1,213	\$594	\$2,690	\$26,245	\$10,081	\$1,509	\$2,434	\$2,936	\$315	\$1,523	\$3,419	\$3,353	\$56,263
TOTAL EST. SUBTASK COST	\$13,344	\$8,029	\$35,532	\$449,036	\$176,277	\$23,996	\$39,450	\$40,844	\$5,668	\$16,756	\$37,614	\$38,805	\$884,822

OPTIONS-SEE TEXT FOR DESCRIPTION	TOTAL	INCREMENTAL COST
BASIC OPTION	\$684,549	
COMPLETE OPTION	\$860,826	\$176,277
REMOB OPTION	\$884,822	\$23,996



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LEGEND

- **FW-4** EXISTING WATER SUPPLY WELL LOCATION AND NUMBER
- **W-98** EXISTING MONITORING WELL LOCATION AND NUMBER
(S AND A ARE WATER TABLE WELLS)
(I AND B ARE INTERMEDIATE DEPTH PIEZOMETER)
(D AND C ARE DEEP PIEZOMETER)
- ▲ **SW-1** SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
- PAVED ROAD
- +++++ RAILROAD TRACKS
- - - INDUSTRIAL PROPERTY BOUNDARY
- 867.04 GROUNDWATER ELEVATION
- - - 868 WATER TABLE CONTOUR (DASHED WHERE INFERRED)

NOTES:

1. BASE MAP, DEVELOPED FROM MAP PROVIDED BY THE CITY ENGINEER'S OFFICE, STURGIS MICHIGAN.
2. WELL LOCATIONS AND ELEVATIONS WERE SURVEYED NOVEMBER AND DECEMBER, 1987 BY PREHN AND REIMAN, GRAND RAPIDS, MICHIGAN.
3. R-1 THROUGH R-5 AND F-1 ARE INDUSTRIAL WATER SUPPLY WELLS.
4. PW-2 THROUGH PW-5 ARE MUNICIPAL WATER SUPPLY WELLS.
5. TV SERIES WELLS WERE INSTALLED BY THE CITY OF STURGIS FOR PRODUCTION WELL SITE TESTING. GW-1, GW-2, GW-4 AND GW-6 INSTALLED AS MONITORING WELLS FOR STURGIS FORDNEY CORP. MW-1, MW-2 AND MW-3 WELL HEADS INSTALLED AS MONITORING WELLS FOR ARBUT LABORATORIES ROSS DIVISION. GW-3, GW-4, GW-7 AND GW-8 INSTALLED AS MONITORING WELLS FOR THE CITY OF STURGIS. W-1 THROUGH W-11 SERIES WELLS INSTALLED BY WABZYN ENGINEERING INC. SEPTEMBER AND OCTOBER, 1987.
6. WATER LEVELS MEASURED BY WABZYN ENGINEERING INC., DECEMBER 9, 1987.
7. SURFACE WATER AND SEDIMENT SAMPLES WERE COLLECTED BY WABZYN ENGINEERING INC. SEPTEMBER, 1987. LOCATIONS ARE APPROXIMATE.



GRAPHIC SCALE

0 500 1000 2000

FIGURE 2

Checked by	TEA
Drawn by	TEA
Designed by	TEA
Reviewed by	TEA
Approved by	TEA
Date	3/24/88
Scale	AS SHOWN
Project Number	1 OF 2
Sheet Number	12000-01
Project Name	REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY STURGIS WELL FIELD STURGIS, MICHIGAN

LEGEND

- PW-4 EXISTING WATER SUPPLY WELL LOCATION AND NUMBER
- W-98 EXISTING MONITORING WELL LOCATION AND NUMBER
 (B AND A ARE WATER TABLE WELLS)
 (I AND B ARE INTERMEDIATE DEPTH PIEZOMETER)
 (D AND C ARE DEEP PIEZOMETER)
- PAVED ROAD
- RAILROAD TRACKS
- INDUSTRIAL PROPERTY BOUNDARY
- 865.17 POTENTIOMETRIC ELEVATION
- 865 WATER TABLE CONTOUR (DASHED WHERE INFERRED)

NOTES:

1. BASE MAP, DEVELOPED FROM MAP PROVIDED BY THE CITY ENGINEER'S OFFICE, STURGIS MICHIGAN.
2. WELL LOCATIONS AND ELEVATIONS WERE SURVEYED NOVEMBER AND DECEMBER, 1967 BY PREIN AND HEMHOFF, GRAND RAPIDS, MICHIGAN.
3. R-1 THROUGH R-5 AND F-1 ARE INDUSTRIAL WATER SUPPLY WELLS.
4. PW-2 THROUGH PW-5 ARE MUNICIPAL WATER SUPPLY WELLS.
5. TV SERIES WELLS WERE INSTALLED BY THE CITY OF STURGIS FOR PRODUCTION WELL SITE TESTING. GW-1, GW-2, MW-4 AND MW-4 INSTALLED AS MONITORING WELLS FOR STURGIS FOUNDRY CORP. MW-1, MW-2 AND MW-3 WELL NESTS INSTALLED AS MONITORING WELLS FOR ARBOL LABORATORIES ROSS DIVISION. GW-3, GW-4, GW-7 AND GW-8 INSTALLED AS MONITORING WELLS FOR THE CITY OF STURGIS. W-1 THROUGH W-11 SERIES WELLS INSTALLED BY WARZYN ENGINEERING INC. SEPTEMBER AND OCTOBER, 1967.
6. WATER LEVELS MEASURED BY WARZYN ENGINEERING INC., DECEMBER 9, 1967.



GRAPHIC SCALE

0 500 1000 2000

FIGURE 3

WARZYN

WARZYN ENGINEERING INC.
STURGIS, MICHIGAN

WARZYN

POTENTIOMETRIC SURFACE MAP
REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY
STURGIS WELL FIELD
STURGIS, MICHIGAN

Printed

Sheet Number

Project Number

12986-02

WARZYN

2 OF 2

WARZYN

WARZYN

WARZYN

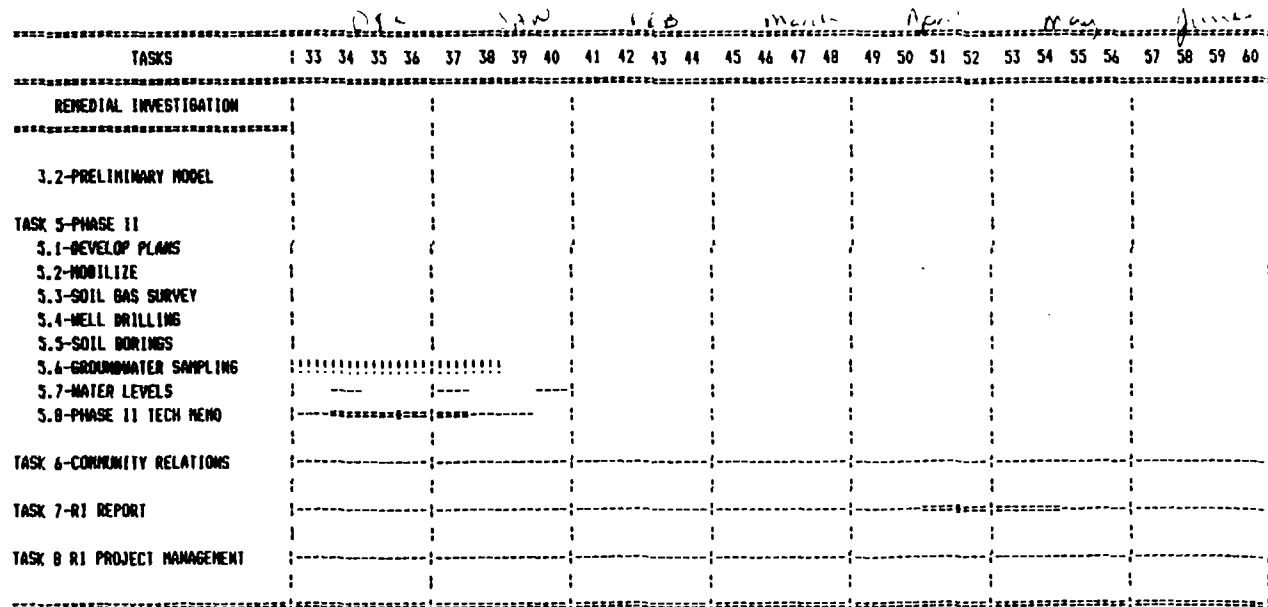
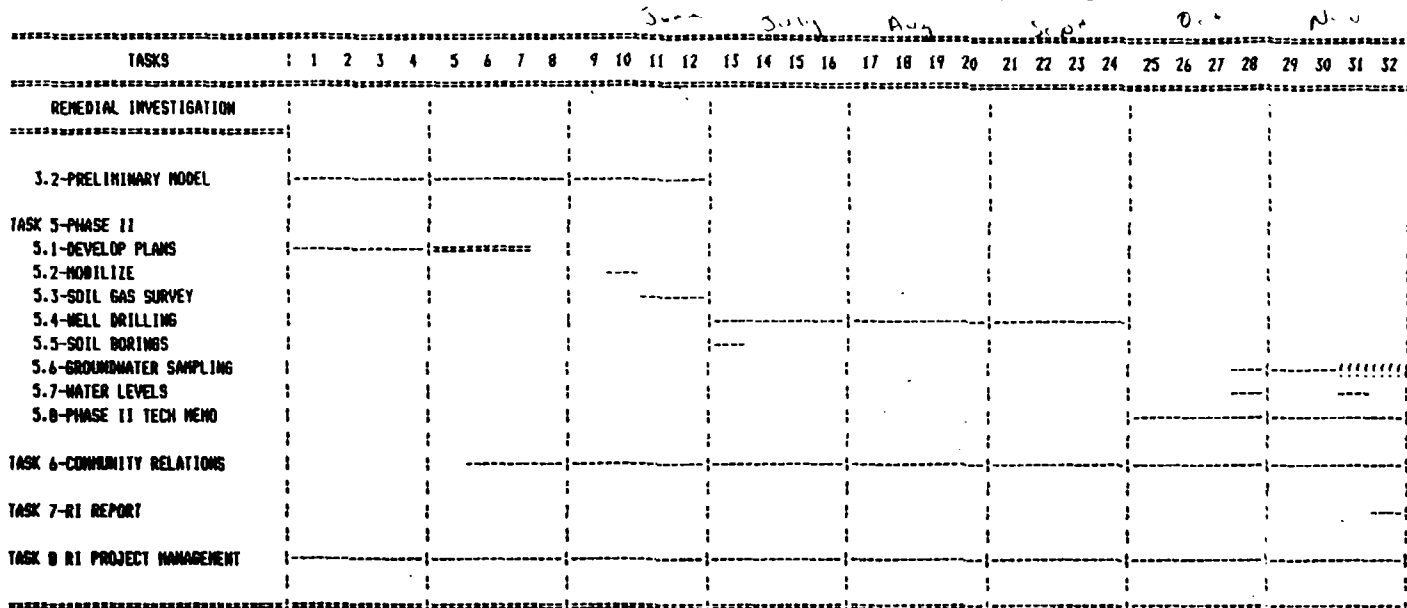
WARZYN

WARZYN

WARZYN

WARZYN

FIGURE 4
PROJECT SCHEDULE
STURGIS WELL FIELD RI/FS



----- - PROJECT ACTIVITIES
 === - MDR REVIEW
 !!!!! - LAB TURNAROUND TIME
 0 - MEETING